2.0 INTRODUCTION

The Nevada Test Site (NTS) environment is characterized by desert valley and Great Basin mountain terrain and topography, with a climate, flora, and fauna typical of the southern Great Basin deserts. The key features that afford protection to the inhabitants of the adjacent areas from potential exposure to radioactivity or other contaminants resulting from operations on the NTS are restricted access, extended wind transport times, bounded on three sides by United States Air Force lands, and the general remote location of the NTS. Also, characteristic of this area are the great depths to slow-moving groundwater and little or no surface water. Population density within 80 km of the NTS is only 0.5 persons/km^2 versus approximately 29 persons/km^2 in the 48 contiguous states. The predominant use of land surrounding the NTS is open range for livestock grazing with scattered mining and recreational areas.

The NTS, located in southern Nevada was the primary location for the testing of nuclear explosives in the continental United States from 1951 to 1992. Historically, nuclear testing has included, (1) atmospheric testing in the 1950s and early 1960s; (2) underground testing in drilled, vertical holes and horizontal tunnels; (3) earth-cratering experiments; (4) open-air nuclear reactor and engine testing; and (5) eleven underground tests for various purposes at other locations in the United States.

NTS activities in 2000 continue to be diverse, with the primary role being to help ensure that the existing United States stockpile remains safe and reliable. Facilities that support this mission include the U1 Facility, Big Explosives Experimental Facility (BEEF), and Joint Actinide Shock Physics Experimental Research Facility (JASPER). Other NTS activities include demilitarization activities, controlled spills of hazardous material at the Hazardous Materials Spill Center (HSC), remediation of industrial sites, processing of waste destined for the Waste Isolation Pilot Plant (WIPP), disposal of radioactive waste, and environmental research. In addition efforts continue to bring other business to the NTS, like aerospace and alternative energy technologies.

2.1 NTS SITE CHARACTERISTICS

The NTS, located in Nye County, Nevada, as shown in Figure 2.1, has been operated by the U.S. Department of Energy (DOE), National Nuclear Security Administration Nevada Operations Office (NNSA/NV), or its predecessors, as the on-continent test site for nuclear explosives testing since 1951. The southeast corner of the NTS is about 88 km (55 mi) northwest of the center of Las Vegas. By highway, it is about 105 km (65 mi) from the center of Las Vegas to Mercury. The NTS encompasses about 3,561 km^2 (1,375 mi^2), an area larger than the state of Rhode Island. The dimensions of the NTS vary from 46 to 56 km (28 to 35 mi) in width (eastern to western border) and from 64 to 88 km (40 to 55 mi) in length (northern to southern border). The NTS is surrounded on the east, north, and west sides by public exclusion areas, called the Nellis Air Force Range (NAFR) (see Figure 2.1). This area provides a buffer zone varying from 24 to 104 km (15 to 65 mi) between the NTS and public lands. The combination of the NAFR

Figure 2.1 Nevada Test Site Location in Nevada

and the NTS is one of the larger unpopulated land areas in the United States, comprising some 14,200 km^2 (5,470 mi^2). Figure 2.2 shows the general layout of the NTS, including the location of major facilities and the NTS Area numbers referred to in this report. The geographical areas previously used for nuclear testing are also indicated in Figure 2.2. Mercury, located at the southern end of the NTS, is the main base camp for worker housing and administrative operations for the NTS.

2.2 TOPOGRAPHY AND TERRAIN

The NTS terrain is typical of much of the Basin and Range physiographic province in Nevada, Arizona, and Utah. There are north to northeast trending mountain ranges separated by gentle sloping linear valleys and broad flat basins at the NTS. The principal valleys within the NTS are the Frenchman Flat, the Yucca Flat, and the Jackass Flats, with the principal highlands consisting of Pahute Mesa, Rainier Mesa, Timber Mountain, and Shoshone Mountain. A large portion of the NTS ranges in elevation from about 914 to 1,219 m (3,000 to 4,000 ft) in the valleys to the south and east to 1,676 to 2,225 m (5,500 to 7,300 ft) in the high country toward the northern and western boundaries.

Surface drainages for Yucca and Frenchman Flats (east side of the NTS) are closed-basin systems that drain onto the dry lake beds (playas) in each valley. The remaining area on the western side of the NTS drains via arroyos and dry stream beds that carry water only during unusually intense or persistent storms. There are no continuously flowing streams on the NTS.

One notable feature of Yucca Flat is the formation of numerous dish-shaped surface subsidence craters as a direct result of nuclear testing (other areas on the NTS are affected on a much smaller scale). Most underground nuclear tests conducted in vertical shafts (also cratering experiments or following some tunnel events) produced surface subsidence craters that occurred when the overburden above a nuclear cavity collapsed and formed a rubble "chimney" to the surface.

2.3 PRECIPITATION

The NTS is between the northern boundary of the Mojave Desert and the southern limits of the Great Basin Desert. This “Transitional Desert” is considered to be typical of either the Dry Mid-latitude or Dry Subtropical climatic zones. The climate is characterized by low precipitation, a large diurnal temperature range, a large evaporation rate, and moderate to strong winds.

Most precipitation in the Transitional Desert occurs in winter and summer. Winter precipitation is generally associated with transitory low-pressure systems originating from the west and occurring as uniform storms over large areas (snowfall to elevations below 5,000 feet in the strongest of these storms). Summer precipitation is generally associated with convective storms originating from the south or southwest and occurring as intense local storms. The average annual precipitation ranges between three and ten inches, depending on elevation. Lower values of this range are typical in valleys, whereas higher values are typical in the surrounding mountains.

2.4 TEMPERATURE

Elevation influences temperatures on the NTS, with higher elevations having a higher sustained cooler temperature and the lower elevations having a higher sustained warmer temperature.

At an elevation of 2,000 m (6,560 ft) Pahute Mesa recorded a maximum temperature in 2000 of 39 °C (102 °F) and a minimum temperature of -11 °C (11 °F). The average maximum temperature was 16 °C (61 °F) and the average minimum was 5 °C (41 °F). In the Yucca Flat

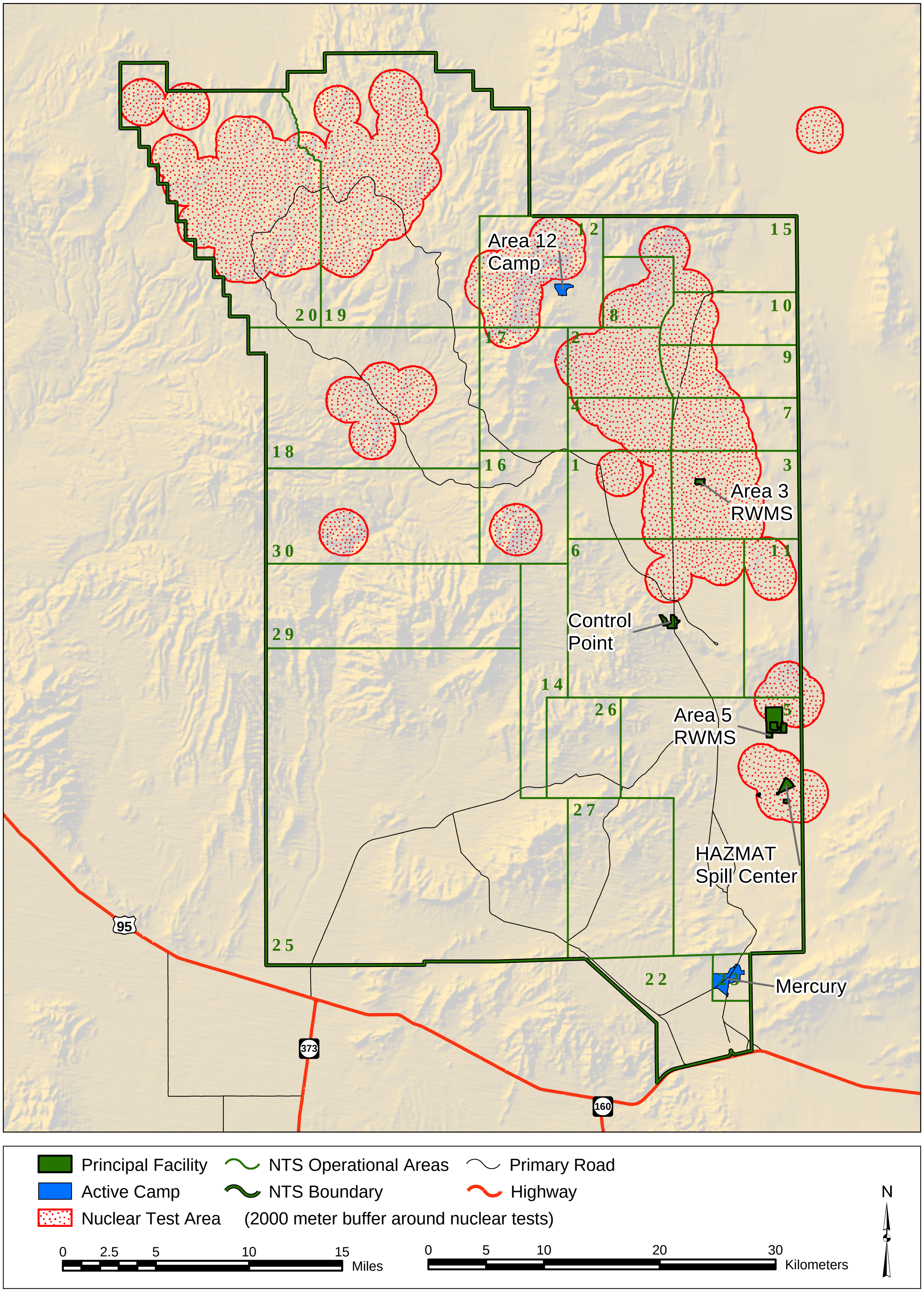

Figure 2.2 Nevada Test Site Operational Areas, Principal Facilities and Testing Areas

basin at an elevation of 1,195 m (3,920 ft), the maximum temperature recorded for 2000 was 48 °C (118 °F) and the minimum temperature was -13 °C (8 °F). The average maximum temperature was 23 °C (73 °F) and the average minimum was 3 °C (38 °F).

2.5 WIND

Winds are primarily southerly during summer months and northerly during winter months. Wind velocities tend to be greater in the spring than in the fall. At the Yucca Playa station, the average annual wind velocity was 11 kph (7 mph); the maximum wind velocity was nearby at the Meteorological Data Acquisition System Station 4 at 137 kph (85 mph). At Area 20 Camp on Pahute Mesa, the average annual wind velocity was 16 kph (10 mph) miles per hour; the maximum wind velocity was 83 kph (52 mph). The multi-year wind roses for selected locations around the NTS are shown in Figure 2.3.

2.6 EVAPORATION

Evaporation at the NTS is high in the flats (Frenchman, Yucca, and Jackass) because of the large incident solar radiation and wind. Potential evaporation is evaporation at a potential, or energy-limiting rate; it is calculated using any of a number of available equations. The potential evaporation usually exceeds ten times the annual precipitation on the valleys of the NTS.

2.7 GEOLOGY

The NTS is located in the south central part of the Great Basin section of the Basin and Range physiographic province. The topography of this province is characterized by north- to northeast-tending mountain ranges, separated by broad, linear valleys and is evident on the eastern portion of the NTS. In the vicinity of the NTS, this series of ridges and valleys is locally disrupted by a large volcanic plateau and an associated complex of overlapping collapse calderas.

During the Paleozoic Era, the NTS region was part of the Cordilleran miogeosyncline, a subsiding trough on the submerged western edge of the North American continent. This miogeosyncline, extending from Mexico to Alaska, received thousands of feet of shallow water deposition, derived from erosion of the nearby continental land mass. As a result, in excess of 30,000 feet of Paleozoic clastic and carbonate rocks was deposited in the NTS region. During the Mesozoic Era, these rocks were complexly folded and thrust faulted in several periods of compressional deformation. The CP Thrust and the Mine Mountain Thrust are the major thrust faults formed during this time in the NTS region. These episodes of mountain building were accompanied by intrusions of granitic plutons, which are represented by the Climax, Twin Ridge, and Gold Meadows stocks on the NTS.

A major period of silicic volcanism began in the central portion of the Great Basin approximately 40 million years ago and spread outward through time. The dominant volcanic activity in the NTS region began about 16 million years ago and continued at least until 0.25 million years ago. A complex of six collapse calderas, five of which overlap, was active along the western portion of the NTS between 16 and 6 million years ago. Ash flow tuffs that erupted from these centers exceed 15,000 ft thickness under Pahute Mesa, a volcanic plateau in the northwestern portion of the NTS. A transition to basalt eruptions occurred approximately six million years ago.

The crustal extension which produced north- to northeast-tending normal faults began between 17 and 14 million years ago in southern Nevada. Uplift and subsidence along these faults resulted in the present-day system of mountain ranges and topographically closed basins.

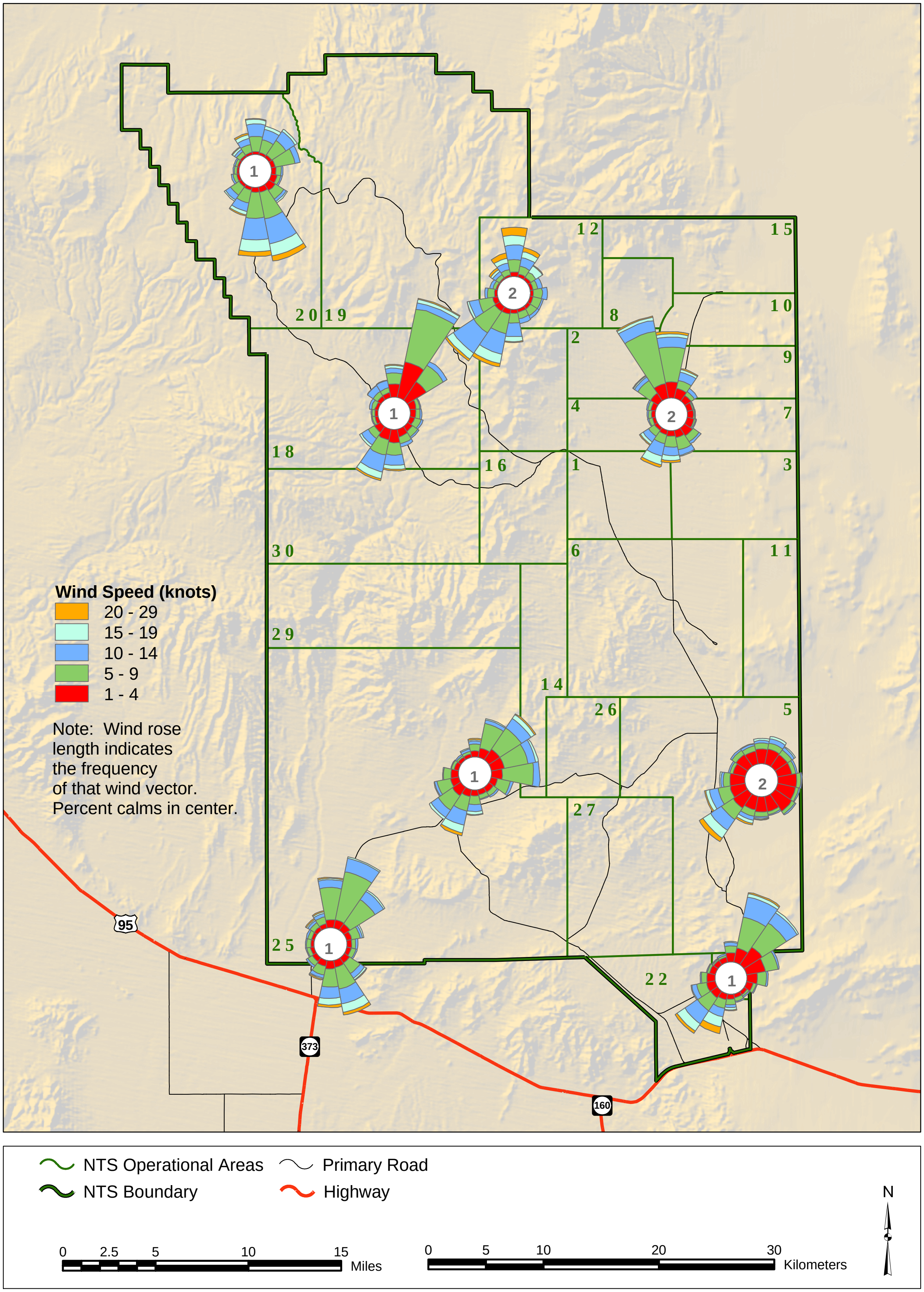

Figure 2.3 Annual Climatological Wind Rose Patterns for the Nevada Test Site - 2000

Alluvium and colluvium from the mountain ranges have filled the basins to depths of several hundred meters or more.

Refer to Chapter 7.0 of this report for a detailed overview of the geology of the NTS.

2.8 HYDROGEOLOGY

Depths to groundwater under the NTS vary from about 210 m (690 ft) beneath the Frenchman Flat playa (Winograd and Thordarson 1975) in the southern part of the NTS to more than 700 m (2,300 ft) beneath part of Pahute Mesa. In the eastern portions, the water table occurs generally in the alluvium and volcanic rocks above the regional carbonate aquifer and is characterized by regional flow from the upland recharge area in the north and east, towards discharge areas at Ash Meadows and Death Valley. In the western portion of the NTS, the water table occurs predominantly in volcanic rocks and moves in a southerly direction toward Oasis Valley, Crater Flat, and/or western Jackass Flats.

Groundwater is the only local source of drinking water in the NTS area. Drinking and industrial water supply wells for the NTS produce from the lower and upper carbonate aquifers and the volcanic and the valley-fill aquifers. Although a few springs emerge from perched groundwater lenses at the NTS, discharge rates are low, and spring water is not used for NNSA/NV activities. North and south of the NTS, private and public supply wells are completed primarily in a valley-fill aquifers.

2.9 ECOLOGY

The NTS is between the northern boundary of the Mojave Desert and the southern limits of the Great Basin Desert. This “Transitional Desert” includes vegetation associations of both deserts. Communities of the Mojave Desert occur over the southern third of the NTS, on bajadas and mountain ranges at elevations below about 4,000 feet. They are limited to areas with mean annual minimum temperatures greater than 28^{o} F and mean annual precipitation less than 7.2 inches (O’Farrell and Emery 1976.) Mojave Desert communities can have highly variable floristic compositions, but all are dominated by creosote bush (*Larrea tridentata*) and variable co-dominant shrubs. Shrub coverage varies from 7 to 23 percent for Mojave Desert communities on the NTS (Beatley 1976.) Above 5,000 feet, the vegetation mosaic begins to be dominated by sagebrush associations of *Artemisia tridentata* and *Artemisia arbuscula* subspecies *nova*. Above 6,000 feet, piñon pine and juniper mix with the sagebrush associations, where there is suitable moisture for these trees.

Most mammals on the NTS are small and often nocturnal in habitat, hence not often seen by casual observers. Rodents are the most important group of mammals on the NTS, based on distribution and relative abundance. Larger mammals include feral horses, mule deer, mountain lions, bobcats, coyote, kit foxes, and rabbits, among others. Among other taxa, the reptiles include the desert tortoise, over 12 lizards, and 17 snakes; 4 of which are venomous. Bird species are mostly migrants or seasonal residents. Most nonrodent mammals have been placed in the "protected" classification by the state of Nevada. The Mojave population of the desert tortoise, *Gopherus agassizii*, is listed as threatened by the U.S. Fish and Wildlife Service. The habitat of the desert tortoises on the NTS is found in its southern third, outside the recent areas of nuclear explosives test activities.

2.10 CULTURAL RESOURCES

Human habitation of the NTS area began at least as early as 10,000 years ago. Various indigenous cultures occupied the region in prehistoric times. The survey of less than 5 percent of the NTS area has located more than 2,000 archaeological sites, which contain the only information available concerning the prehistoric inhabitants. The site types identified include rock quarries, tool-manufacturing areas, plant-processing locations, hunting locales, rock art, temporary camps, and permanent villages. The prehistoric people's lifestyle was sustained by a hunting and gathering economy, which utilized all parts of the NTS.

While major springs provided perennial water, the prehistoric people developed strategies to take advantage of intermittent fresh water sources in this arid region. In the nineteenth century, at the time of initial contact, the area was occupied by Paiute and Shoshone Indians. Prior to 1940, the historic occupation consisted of ranchers, miners, and Native Americans. Several natural springs were able to sustain livestock, ranchers, and miners. Stone cabins, corrals, and fencing stand today as testaments to these early settlers. The mining activities included two large mines: one at Wahmonie, the other at Climax Mine. Prospector claim markers are found in these and other parts of the NTS. Cane Springs was the last mining boom town in Nevada and was a sizeable town in the years 1929 and 1930. Native Americans coexisted with the settlers and miners, utilizing the natural resources of the region and, in some cases, working for the new arrivals. They also maintained a connection with the land, especially areas important to them for religious and historical reasons. These locations, referred to as traditional cultural properties, continue to be significant to the Paiute and Shoshone Indians.

2.11 NTS NUCLEAR TESTING HISTORY

Between 1940 and 1950, the area now known as the NTS was under the jurisdiction of Nellis Air Force Base and was part of the Nellis Bombing and Gunnery Range. The NTS was established in 1951 as the primary location for testing the nation's nuclear explosive devices. Tests conducted through the 1950s were predominantly atmospheric tests. These tests involved a nuclear explosive device detonated while on the ground surface, on a steel tower, suspended from tethered balloons, or dropped from an aircraft. Several tests were categorized as "safety" experiments, including transport and storage tests, involving the destruction of a nuclear device with nonnuclear explosives. Some of these tests resulted in dispersion of plutonium in the test vicinity. One of these test areas lies just north of the NTS boundary, and four others, involving transport/storage safety, lie at the north end of the NAFR. All nuclear device tests are listed in DOE/NV Report NV-209 (DOE 2000b).

The first underground test, a cratering test was conducted in 1951. The first test totally contained underground was in 1957. Testing was discontinued during a moratorium that began October 31, 1958, but was resumed in September 1961, after tests by the Union of Soviet Socialist Republics began. Since late 1962, nearly all tests have been conducted in sealed vertical shafts drilled into Yucca Flat and Pahute Mesa or in horizontal tunnels mined into Rainier Mesa. Five earth-cratering (shallow-burial) tests were conducted over the period of 1962 through 1968 as part of the Plowshare Program, that explored peaceful uses of nuclear explosives. The first and largest Plowshare crater test, SEDAN (PHS 1963) was detonated at the northern end of Yucca Flat. There have been no United States nuclear explosive tests since September 1992.

Other nuclear testing history at the NTS has included the Bare Reactor Experiment - Nevada series in the 1960s. These tests were performed with a 14-MeV neutron generator mounted on a 465-m (1,530-ft) steel tower, used to conduct neutron and gamma-ray interaction studies on various materials. From 1959 through 1973, a series of open-air nuclear reactor, nuclear engine, and nuclear furnace tests was conducted in Area 25, and a series of tests with a nuclear ramjet engine was conducted in Area 26.

2.12 SURROUNDING AREAS

Figure 2.4 is a map of the offsite area showing a variety of lands uses and the various governmental agencies responsible for managing the land. The lands, with the exception of the Department of Defense and NNSA/NV, are open to a wide variety of uses such as farming, mining, grazing, camping, fishing and hunting, within a 300-km (180-mi) radius of the Control Point-1.

2.13 DEMOGRAPHY

The population of the area surrounding the NTS has been estimated by the Nevada State Demographer Office and is predominantly rural. Nevada annual population estimate for Nevada Counties, Cities, and Unincorporated Towns is 2,066,831, with all but 641,108 residing in Clark County. Excluding Clark County, the major population center, the population density within a 150-km (90-mi) radius of the NTS is about 0.5 persons/km^2. In comparison, the 48 contiguous states (1990 census) had a population density near 29 persons/km^2. Several small communities are located in the area (populations in parenthesis), Alamo (507), Amargosa (1,271), Beatty (1,255), Goldfield (574), Indian Springs (1,387), Pahrump (26,399), and Tonopah (3,086). The largest of these communities being Pahrump Valley approximately 50 mi (80 km) south of the NTS Control Point (CP-1), which is near the center of the NTS.

The Mojave Desert of California, which includes Death Valley National Monument, lies along the southwestern border of Nevada. This area is still predominantly rural; however, tourism at Death Valley National Park swell the population over 5,000 on any particular day during holiday periods during mild weather.

The extreme southwestern region of Utah is more developed than the adjacent portion of Nevada. The largest community is St. George, located 220 km (137 mi) east of the NTS, with a population of 29,000. The next largest town, Cedar City, with a population of 14,000, is located 280 km (174 mi) east-northeast of the NTS.

The extreme northwestern region of Arizona is mostly rangeland, except for that portion in the Lake Mead recreation area. In addition, several small communities lie along the Colorado River. The largest towns in the area are Bullhead City, 165 km (103 mi) south-southeast of the NTS, with a population estimate of 22,000, and Kingman, located 280 km (174 mi) southeast of the NTS, with a population of about 13,000.

2.14 MISSION AND NATURE OF OPERATIONS

The present mission of the NNSA/NV is described by the following five statements:

- **National Security:** support the Stockpile Stewardship Program through subcritical and other weapons physics experiments, emergency management, test readiness, work for other national security organizations, and other experimental programs.

- **Environmental Management:** support environmental restoration, groundwater characterization, and low-level radioactive waste management.

- **Stewardship of the NTS:** manage the land and facilities at the NTS as a unique and valuable national resource.

Figure 2.4 Land Use Around the Nevada Test Site

- **Technology Diversification:** support nontraditional Departmental programs and commercial activities which are compatible with the Stockpile Stewardship Program.

- **Energy Efficiency and Renewable Energy:** support the development of solar energy, alternative fuel, and energy efficiency technologies.

2.15 STOCKPILE STEWARDSHIP

There were five subcritical experiments which involved small amounts of special nuclear material that do not reach the fissioning stage during the experiment. In addition, 30 experiments were conducted at the BEEF and construction was completed on JASPER.

2.16 ENVIRONMENTAL MANAGEMENT

The Environmental Restoration efforts included remediating 50 industrial sites. The Underground Test Area program drilled three holes and continued work on modeling efforts.

Approximately 650,000 cubic feet of low-level waste was disposed of at the Area 3 and Area 5 Radioactive Waste Management Sites (475 shipments). In addition, 195 drums of transuranic waste were processed prior to shipment to the WIPP in New Mexico.

2.17 HAZARDOUS MATERIALS SPILL CENTER (HSC)

The NNSA/NV's HSC is a research and demonstration facility available on a user-fee basis to private and public sector test and training sponsors concerned with the safety aspects of hazardous chemicals. The site is located in Area 5 of the NTS and is maintained by Bechtel Nevada. The HSC is the basic research tool for studying the dynamics of accidental releases of various hazardous materials. The facility was active for 37 weeks in Calendar Year 2000.

Rainier Mesa (No Date Provided)